MTM

THE JOURNAL OF METHODS-TIME MEASUREMENT

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In This Issue . . . . .

MTM ASSOCIATION FOR STANDARDS AND RESEARCH

The Journal of Methods-Time Measurement is dedicated to the technical aspects, application developments and general news items concerning the advancement of MTM.

The Journal encompasses the fields of endeavor that were formerly publicized in the MTM Newsletter and MTM Bulletin.

The technical section of the Journal is concerned chiefly with recent research developments both from the established research program at the University of Michigan, Ann Arbor, Michigan, and from somewhat smaller allied projects being conducted throughout the Association membership.

New applications of MTM as well as refinements of established applications are presented in the Application Section to illustrate specific approaches to management problems that can be solved through the use of Methods-Time Measurement.

Current events in the lives of persons associated with MTM are described in the general news section.

The Editorial Staff welcomes contributions for all three sections described.

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MTM ASSOCIATION FOR STANDARDS AND RESEARCH

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In order to carry out this purpose, the Association: conducts basic and applied research; compiles available information regarding the development and application of MTM; and establishes standards to perpetuate the consistency of high quality work accomplished by the member organizations and individuals engaged in the use of MTM.

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TECHNICAL

RESEARCH DEVELOPMENTS IN MOVES WITH WEIGHTS

By David L. Raphael
Research Associate, Engineering Research Institute, University of Michigan

(An address given at the Third Annual International MTM Conference at the Hotel Statler, New York, October 8, 1954, on the above subject.)

INTRODUCTION

The subject of my discussion today is "Research Developments in Moves with Weights." It is a subject which should be of interest to all those who must deal with the organization and control of manual activity. Let us examine the problem faced by such a person. In setting production standards, in evaluating present work methods, and in devising methods of performing new operations, he knows intuitively that some sort of allowance must be made for movements involving weight. He may also feel, that heavy weights in an operation may in some way deform the motion pattern. Therefore, he must devise some means of handling and accounting for these weighted movements. This is especially so when he is faced with an operation in which a major portion of the cycle is composed of such movements.

What then can he do? He will find no systematic treatment of motions involving weights in the literature. He, therefore, must operate without any reasonable understanding of the thing he wishes to deal with or control. He can make time allowances for weights involved in an operation; either grossly by time study techniques, or by determining allowances for individual motions, through the use of one of the systems of predetermined times. This will result in more or less accurate adjusted time standards. Fundamentally, this is the sum total of what he is able to do.

Let us look at what he is not able to do.

1) For methods work, he is unable to properly understand what is causing increases in cycle time and in what manner. Thus, he can not improve the motion pattern and effectively minimize the influence of weight. In setting up new operations, it is not possible for him to properly establish an optimum motion sequence, in fact, a method might be devised which is essentially very inefficient, if not unworkable.

2) The time allowance for weights, which he has developed for an operation might prove to be inaccurate. The resulting time standard would be too "tight" or too "loose." In either case, this is an undesirable result. However, he is unable to pinpoint the cause. It might be due to the possibly incorrect allowance factors of the predetermined time system which he used. It also might be due to improper application of these allowances, granted that they are valid. Or the incorrect result might come from both of these possibilities. He has no way of knowing, as his knowledge is mainly intuitive, leavened only with fragments of information.

In addition, the various means of handling weights in different predetermined time systems are themselves somewhat inconclusive. Different systems handle weights in different ways. Since so little is known about the characteristics of weighted movements, it is almost impossible to know whether they are being applied correctly to any given operation, or, when applied correctly, whether they will produce an accurate result.

It is clear from this discussion, that the problems of effectively handling weighted movements necessarily is a two-fold one.

1) We must have a clear and understandable picture of the characteristics of these movements under a variety of conditions.

2) Once we have this characteristic framework, we can then develop a practical set of adjustment factors or allowances in terms of it.

Without first determining this framework, it will be almost impossible to validly determine allowances. This is the basic weakness of present weight adjustment factors. They have been developed to account for a phenomenon whose characteristics are incompletely or incorrectly understood. As a result, not only may they be inaccurate themselves but also it is very difficult to apply them in a valid and meaningful way.

Because of this situation, this project was set up to investigate moves with weight. Its purpose was to supply solutions to both aspects of this weight problem, i.e., to determine the basic characteristics, and then to determine the proper time adjustments in terms of these characteristics. The results of this research have, I hope, made appreciable progress on both counts.

BASIC CHARACTERISTICS

I should like now to discuss what research has indicated concerning the basic characteristics of moves with weight.

To begin, just what do we mean when we talk about a "Move with weight"? Basically, we are concerned with an arm movement in which an object, held by the hand, is transported from one location to another. The object so moved, of course, has a weight which may be quite large. From a physiological standpoint, the arm and hand involved must do two things:

1) The muscles of the hand and arm must get the object under control.

2) The muscles of the arm must then actually move the arm through space to the place where the object will be released.

It should be pointed out that getting the object under control involves more than a grasping movement. When the weight to be moved becomes large, something more than merely closing the fingers on the object is involved. There must be the application of pressure sufficient to keep the object under control. It is important to separate this Apply Pressure from the Grasp. The Grasp is sufficient to get an object under control when the weight involved is negligible. This Apply Pressure is the additional element required when weights of appreciable size are involved. It is, therefore, a characteristic unique to Moves with Weights. To combine it with a Grasp would only confuse what we are trying to clarify.

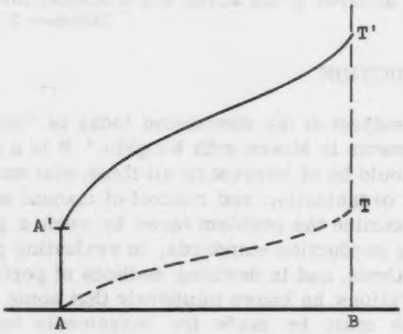
COMPONENTS OF A
MOVE WITH WEIGHT

Static	Weight brought under control of the muscles of the hand and arm. No movement.
Dynamic	Weight transported from one location to another. Accomplished by movement of the arm.

Slide 1.

We have, then, two basic components of a Move with Weight, a static and a dynamic component. The static component is the time required for the muscles of the hand and arm to take up the weight of the object. This occurs *after* the fingers have closed on the object. It must be accomplished before any actual movement can take place. When it is accomplished, the dynamic component can occur. This is the component in which the object, now under control, is actually moved to a new location.

Where pertinent, these two components were studied separately. This was done since it was found that the effect on these components differed for certain variables. In referring to these components in the following discussion, the terms "AP" and "movement" will be used; "AP" referring to the static component, and "movement" referring to the dynamic one.



Slide 2. Distance-Time Curve of a Move Motion

To better understand the two components, let us examine the distance-time curve of Move. This is portrayed in Slide 2. Distance runs in the horizontal direction. The distance of performance of the motion is from A to B. The time axis runs vertically, but is not shown to obtain clearer presentation of the motion. Note the broken curve A.T. This shows the distance time behavior of an ordinary Move motion where negligible weight is transported. The non-linear nature of the curve is due to the acceleration and deceleration necessary to perform it. This ordinary Move starts at zero time and is performed in a time indicated by the distance the curve rises. This is the time indicated by the vertical interval BT. In other words, the broken curve shows a Move involving a negligible weight performed over distance AB in time BT.

The solid curve shows a Move where a considerable weight is being transported. Both components of a Move with weight appear. The AP time is indicated by the vertical line AA'. This is the time required for the hand and arm to take up the weight of the object. No distance has been traversed. The movement component is portrayed by the curve A'T'. Note that this curve, rises at a steeper rate over the distance AB than the curve AT. The time for movement, when a large weight is involved, is greater than that for a move, over the same distance, with negligible weight.

To state this somewhat differently, the broken curve can be considered a Move where the weight involved is very small. In this case, the AP is zero and the only component requiring time is that of movement. This time is BT. The solid line and curve represent a Move where the weight is quite large. Its AP is *not*

zero and requires the time AA' for performance. After the AP, the movement A'T' ensues. It consumes time at a greater rate than the movement of the previous motion. Not only has the time for an AP been added to the Move performance time, but also an increase in the time for the movement component. The total time of the whole Move with weight is that of the vertical interval BT'.

These two, AP and movement, make up a Move with weight. They will be affected in various ways by certain variables and conditions of performance. It is these variables and conditions which we must next consider. The major ones are listed on the next slide.

```
VARIABLES AFFECTING A
MOVE WITH WEIGHT

DISTANCE
CONTROL
WEIGHT
HAND PERFORMING
DIRECTION
METHOD OF MOVEMENT
   Spatial
   Sliding
SEX
```

Slide 3.

In slide 3 are listed the major variables which might affect the components of a Move with weight. Most of them are obvious. However, let us run down the list briefly so that we can be sure of what is meant.

***Distance* — this of course refers to the arc distance traversed in performing the motion.**

***Control* — this refers to the precision required to perform a Move. A concrete example would be the three MTM cases of Move; A — against a stop (low control), B — to an approximate location (medium control), and C — to an exact location (high control).**

***Weight* — this is the weight, in pounds, of the object to be moved.**

***Hand* — This refers to whether the Move is performed with one hand or with both hands holding the object.**

***Direction* — for simplicity, this can be broken down into two categories.**

1) **The angle the motion makes with a horizontal plane. For example, horizontal moves have a direction of 0 degrees, while vertical moves have a direction of 90 degrees.**
2) **The angle the motion makes with the vertical plane of the body. This would cover such motions as forward and backward moves and moves from side to side.**

***Method of Movement* — this refers to the two possible ways in which an object can be moved. First, the object may be moved spatially without contact with any solid surface. Second, the object may be slid across a surface.**

***Sex* — Here we are interested in any difference in performance which may be due to inherent differences in male and female capacities.**

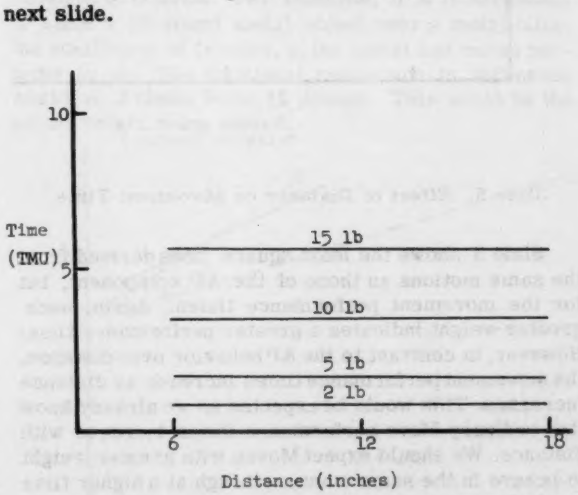
These then are the variables which affect a Move with weight. How they do this will vary from one to the other. Further, it is only by knowing their effects that we can draw a reasonably clear picture of the behavior of Moves. Therefore, we shall now discuss the behavior of the Move with weight as it is affected by each of these.

We shall first concern ourselves with three of these variables. These are weight, distance and control. These can be considered the fundamental variables affecting a Move with weight. Allowances and adjustment factors for weights must be derived with reference to all three, primarily in terms of the effect of weight, but with due concern for the distance and control variables as they relate to that of weight. This will become clearer in our discussion.

Distance and Weight

The effect of distance and weight on the two components of a Move, AP and Movement, are quite different. Therefore, we shall discuss them separately.

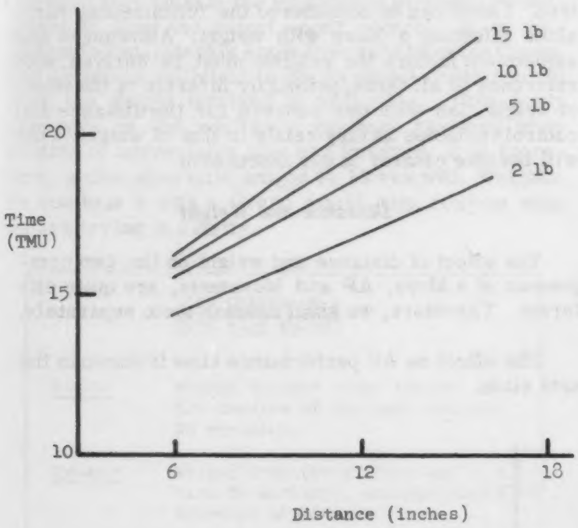
The effect on AP performance time is shown in the next slide.



Slide 4. Effect of Distance on AP Time

In slide 4 we have four distance vs. time lines fitted by the method of least squares to actual research

data. They indicate the change in AP performance time as distance increases. These are for Moves in which 2, 5, 10 and 15 pound objects were moved. The point of interest here is the fact that, for any given weight, the AP time remains the same, no matter what the distance of the Move will be. This is not too surprising, since AP is static and no movement takes place. The AP performance time is independent of the distance. In addition, this AP time becomes larger as the weight increases. Any particular weight, regardless of the distance moved, will require a fixed AP time determined solely by this weight. Here we have an indication of the importance of separating a Move into its two components. A set of weight allowances for AP will depend only on the weight to be moved. However, as we shall soon see, such allowances for movement will depend not only on weight but also on distance.



Slide 5. Effect of Distance on Movement Time

Slide 5 shows the least square lines derived from the same motions as those of the AP component, but for the movement performance times. Again, each greater weight indicates a greater performance time. However, in contrast to the AP behavior over distance, the movement performance times increase as distance increases. This would be expected as we already know that ordinary Move performance times increase with distance. We should expect Moves with greater weight to behave in the same manner, though at a higher time level. Obviously time allowances for the weight moved must allow for both weight and the distance involved as far as the movement component is concerned.

Control

Since the effect of control, in general, parallels that of distance, we shall not reproduce it pictorially. Suffice it to say that movement times also increase with increasing control for each weight moved. Further, the AP times still tend to depend on weight alone, not increasing with increasing control. However, research indicated one possible exception to this last statement. AP times did seem to show some tendency to increase when the control level was very high. Further research is required to more completely investigate the significance of this tendency.

Let us summarize the effect of these three variables:

AP performance times

1) increase as weight increases
2) remain constant as distance increases
3) remain constant as control increases (with some reservation)

Movement performance times

1) increase as weight increases
2) increase as distance increases
3) increase as control increases

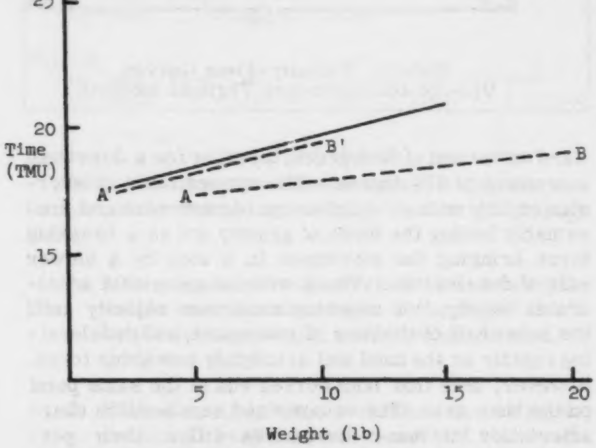
Our research has further shown that, on a fixed weight level, the effect on the movement performance time of this given weight tends to be proportionately or percentagewise the same for all distances and all levels of control. This means that a given weight will bring about a *percentage* increase in time which will be essentially the same at any distance and at any level of control. At the same time, the *actual* increase in time will differ according to the distance or control involved.

Thus, the types of allowances applicable to these two components will differ. For the AP component, it can be an *actual direct time allowance* for the weight involved. Distance and control have no effect on AP time. It varies only with weight. For the movement component, it will be a *percentage time allowance*, thus adjusting movement time at any given distance and control level. This is necessary since movement times vary with distance and control as well as with weight.

We now have a picture of how these three fundamental variables affect a Move with weight. We have also indicated how weight allowances can be developed from them. It is now necessary to discuss the effect of the other variables which have been mentioned. These were the number of hands performing the move, the method of movement (spatial or sliding), the direction of movement, and male or female performance. All of these might be better classified as a group "separate" from the fundamental variables, specifically as conditions of performance. How does a Move with weight behave, then, under these several conditions of performance?

We shall first consider one and two handed Moves.

When both hands are used to perform a Move with weight, the weight of the object is distributed equally between the two hands. This produces a motion whose characteristics are not significantly different from those of the equivalent one handed move in which an object of one-half the weight of the original is transported. This applies to both the AP and movement portions of the motion.



Slide 6. Adjustment of Two-handed Moves Movement Time

Slide 6 shows graphically the behavior of the research data. The lines are least squares regressions fitted to these data. The solid line represents the trend of performance times for one handed movements. as the weight increases. The broken lines represent the two handed movements in the same manner. Line AB shows the two handed movement times plotted against the total weights of the objects. These performance times are appreciably smaller than those for one handed movements of the same weight. However, when the weights are halved, line A'B' results. Note that at one half the weight, the differences between one and two handed movements become negligible. In fact, tests show no significant difference between them. Since the similar figure for AP times shows exactly the same behavior, it will not be reproduced here. This slide clearly shows the relationship between one and two handed Moves with weight. If a weight is moved with two hands, the motion will be performed in the amount of time required for one hand to move one half the original weight, or, in the other direction, a one handed move of a given weight is equivalent in time to a two handed move of twice the given weight. This is a perfectly logical conclusion. With a two handed move, the weight of the object is supported at two points, the weight being distributed equally, one half to each. We then have two simultaneous one handed moves of one half the weight of the object. They would naturally be performed in the appropriate amount of time.

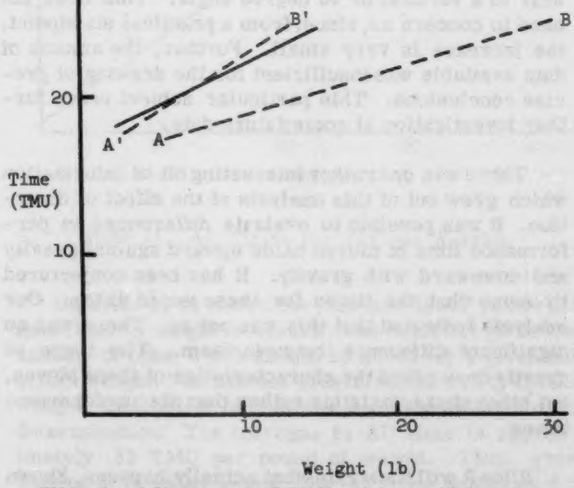
The relationship between spatial and sliding moves presents a somewhat different problem. When a move is performed by sliding an object over a surface, rather than moving it spatially, the object weight no longer is being moved. What we have here is an example of frictional phenomena rather than one of a weight due to the force of gravity. The weight being moved is actually the frictional resistance in pounds which must be overcome to produce the sliding movement. This frictional resistance can be determined by a familiar relationship. When the object to be slid is resting on a horizontal table, the frictional resistance on pounds is equal to the weight of the object multiplied by a coefficient determined by the nature of surfaces in contact. This coefficient is known as the coefficient of friction.

COEFFICIENTS OF FRICTION
FOR ADJUSTMENT OF WEIGHTS IN SLIDING MOTIONS

Surface	μ (range)	μ (average)
Wood on Wood	0.3 to 0.5	0.4
Wood on Metal	0.2 to 0.6	0.4
Metal on Metal	-	0.3

Slide 7.

In slide 7 we have a table showing these coefficients for common types of surfaces met with in manual operations. The Greek letter, μ, is the symbol for the coefficient of friction. For example, if it is necessary to slide a 50 pound metal object over a metal table, the coefficient of friction, μ, for metal and metal surfaces is .3. The frictional resistance in this case would be .3 times 50 or 15 pounds. This would be the actual weight being moved.



Slide 8. Adjustment of Sliding Moves Using the Coefficient of Friction

Slide 8 shows how the application of these coefficients actually worked with our research data. In this instance the objects were wooden boxes slid over a horizontal wooden surface. The coefficient of friction was, therefore, .4. The three lines are least squares regression lines fitted to the data. The solid line represents the trend of performance times of spatial moves as weight increases. The broken line AB shows the performance times of the sliding moves plotted against the weight of the objects. Line A'B' are these same performance times plotted, in this case, against the frictional resistance in pounds. What is indicated here is that a sliding move against frictional resistance is equivalent in performance time to a spatial move where the weight is equal to the frictional resistance. Thus, moving a weight spatially or sliding against a frictional resistance equal to the weight are essentially the same thing as far as performance time is concerned.

The relationship between spatial and sliding moves, then, is precisely that between frictional resistance and the weight of the object.

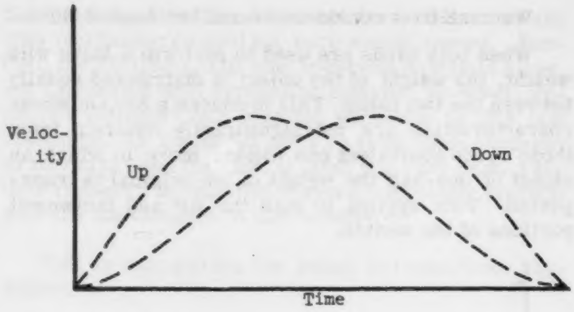
Direction

Concerning the direction of movement, the major points can be covered briefly. Analysis of the research data indicated that movement made in relation to the vertical plane of the body, show no significant differences in performance time. These include such movements as forward from the body, backward to the body, and right and left movements away from and toward the body. They involved moves of from 2 to 15 pounds over distances from 6 to 24 inches. All motions of this type can be considered the same, as the direction does not affect their performance times significantly.

However, movements made at various angles to the horizontal did indicate a significant increase in performance time as the angle of movement approached near to a vertical or 90 degree angle. This does not need to concern us, since, from a practical standpoint, the increase is very small. Further, the amount of data available was insufficient for the drawing of precise conclusions. This particular subject needs further investigation at some future date.

There was one rather interesting bit of information which grew out of this analysis of the effect of direction. It was possible to evaluate differences in performance time of moves made upward against gravity and downward with gravity. It has been conjectured by some that the times for these would differ. Our analysis indicated that this was not so. There was no significant difference between them. The force of gravity does effect the characteristics of these Moves, but other characteristics rather than the performance times.

Slide 9 will illustrate what actually happens. Shown here are two velocity vs. time curves. One for an up-



Slide 9. Velocity-Time Curves
Upward and Downward Vertical Motions

ward movement of 90 degrees, the other for a downward movement of 270 degrees. The upward move accelerates rapidly with an initial surge of movement and presumably letting the force of gravity act as a breaking force bringing the movement to a stop by a slower rate of deceleration. The downward movement accelerates slowly, not reaching maximum velocity until the latter half of the time of movement, and decelerating rapidly as the hand and arm apply a braking force. However, note that both curves end at the same point on the time axis. The velocity and acceleration characteristics of these movements differ; their performance times do not.

I shall deal only in passing with the difference in male and female performance. A significant difference was indicated between the performance times of males and females. In general, the difference appears when larger weights are being moved. Again, insufficient data was available to provide meaningful and specific determination of this difference. All that was possible was to determine that the difference did exist and to describe some general characteristics of it.

Application

With this discussion of the various conditions of performance, we are now ready to spell out a procedure for making time adjustments for Moves with weight. The information which we have developed about the characteristics of these Moves will provide the key to a valid technique.

The procedure is in two steps:

1. Find, for a given motion, what the net actual weight being moved is, as this is determined by the motion's condition of performance. This may often differ from the gross or object weight.

2. Then, apply the proper time allowance to the motion appropriate for this net actual weight.

We carry out the first step in the following manner.

The determination of the net actual weight is a fairly simple procedure. There are only two major conditions of performance which are involved, the number of hands performing the Move and whether the Move is performed spatially or by sliding.

RULES TO DETERMINE NET ACTUAL WEIGHT	
SPATIAL	
One Hand	Weight of object
Two Hands	1/2 weight of object
SLIDING	
One Hand	Weight of object x coef. of friction
Two Hands	1/2 weight of object x coef. of friction

Slide 10.

Slide 10 summarizes the necessary rules for determining the net actual weight. Let us go through them.

1. With a spatial Move performed by one hand, the weight moved is the weight of the object itself. In this case, the net actual weight is equal to the gross weight.

2. With a spatial Move performed by two hands, the actual weight moved is one half the weight of the object. In other words, the net actual weight moved by each hand simultaneously is one half of the object or gross weight.

3. With a sliding Move performed by one hand, the actual weight moved is only the frictional resistance to movement.

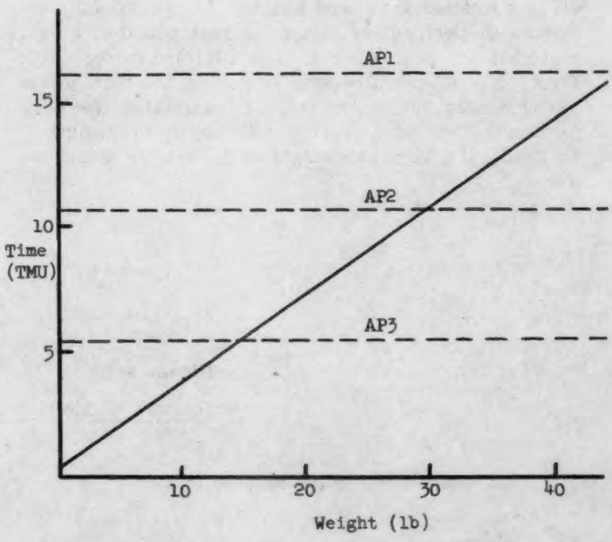
   This is found by multiplying the weight of the object by the appropriate coefficient of friction determined by the nature of the surfaces in contact. In this case, the net actual weight will be only a small proportion of the gross weight.

4. With a sliding Move performed by two hands, the actual weight moved is the frictional resistance of only one half of the weight of the object. This is found by first dividing the gross object weight by two, thus accounting for the fact that two hands are being used. Then, multiplying this result by the appropriate coefficient of friction, the net actual weight moved will be obtained.

To illustrate these rules, suppose an operator must move a 20 pound metal object. Further, assume that his workplace consists of a wooden table. If he moves the weight spatially with one hand, he moves the total weight of the object, 20 pounds. If he uses both hands, he has reduced the actual weight to 10 pounds. If he slides it across the table, with one hand, the actual weight is the product of .4, the value of μ for wood and metal surfaces, and 20, the gross weight of the object. The actual weight becomes 8 pounds. If he uses both hands to slide the object, the weight is the product of .4 and 10 pounds, or a net actual weight of 4 pounds. You can see from this that the net actual weight can show extreme variation depending on the particular method of performance. In this example it ran from 4 to 20 pounds, though the gross weight remained unchanged. Each one of these different net actual weights will require a different time allowance. To not determine them may lead to inaccurate or erroneous time adjustments.

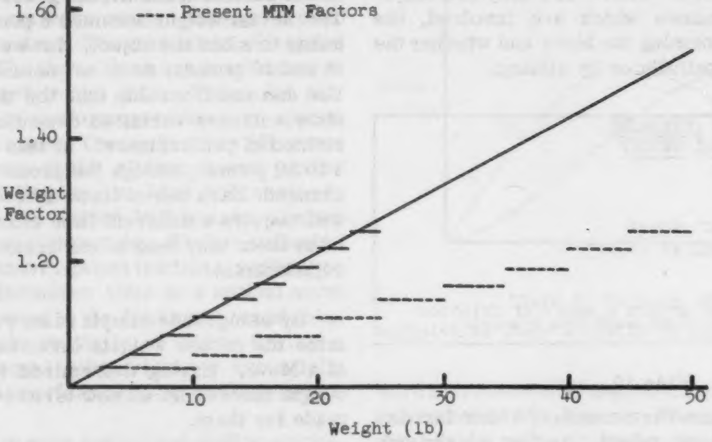
By using these simple rules you can quickly determine the proper weights involved in the performance of a Move. Having determined how to find the actual weight moved, let us now turn to the allowances to be made for them.

As mentioned before, the allowances fall into two classes; one for AP times and the other for movement times. The AP allowances will be in the form of actual times and the movement allowances in the form of a percentage.



Slide 11. AP Times for Various Weights

On slide 11 is shown the increase in AP performance time as weight increases. The solid line gives the amount of time which should be added for a given net actual weight. The amount is determined solely by the weight; the control or distance does not enter into its determination. The increase in AP time is approximately .35 TMU per pound of weight. Thus, when moving a 10 pound weight, the AP time would be 3.5 TMU's.



Slide 12. Weight Adjustment Factors Movement Time

This slide shows the percentage increase in movement time as weight increases. It is the straight solid line in the figure. Using the percentage makes it possible to adjust the time for any distance or control level. The proper percentage adjustment can be read off this line for any given weight. The percentage increase in performance time for each pound of weight moved is 1.1 percent or as a multiplying factor .011. Thus, if a 10 pound weight is moved, the time would be increased by 11 percent. Assume that the performance time of a motion with negligible weight is 15 TMU. If a 10 pound weight is moved, we would increase this time by 11 percent or 1.65 TMU. In addition, we would add the AP time of 3.5 TMU. The performance time of the 10 pound Move with weight would be, then, 19.15 TMU.

I have attempted this morning to spell out the major results of the research into Moves with weight. They help to fill in, at least partially, some of the gaps in our present knowledge of human motions, and provide more accurate and effective methods of handling Moves with weight.

APPLICATION

TIME FORMULA DEVELOPMENT

by C. G. Downen
White-Rodgers Electric Company

Editors note:

The Journal has received numerous requests from readers for information on time formulas.

Other work by this author has been printed in the Journal and the Editor wishes to publicly express the Association's appreciation to Mr. Downen for his efforts to present the information to the readers of this publication.

The following time formula was developed for "sorting time slips". This application to clerical operations is both interesting and informative.

Although we do not have incentives or measured day work in office operations as yet, I was interested in developing an M.T.M. formula for one of our simple clerical operations to determine if this data could be used on this type of operation. Hence, the formula for sorting time slips. Since I am rather a novice at this sort of thing I am sure I am laying myself open to considerable criticism both as to form and development of the data. But because of this criticism I hope to improve in the use of this technique. Truly, fools rush in where angels fear to tread!

We have three fabricating sections (departments) in our plant:

1. Punch Press
   a. Punch Presses
2. Screw Machine
   a. Automatics
   b. Turret Lathes
   c. Hand Screw Machines
   d. Bench Lathes
3. Drill Press
   a. Drill Presses
   b. Semi-Automatic Millers
   c. Tappers
   d. Spot and Seam Welders
   e. Broach
   f. Centerless Grinder, etc.

Formula — Standard Time Office

Part: Time Slips
Operation: Sort Time Slips
Work Station: Desk

Each Job Standard Hours

$$(BN_3) + (GN_1) = (\text{TABLE I} \times N_2) + (IN_2) + .009291$$

Where:

N_1 = Number of packs of incentive time slips.

N_2 = Number of time slips sorted into "part" and "numerical" sequence (direct incentive labor).

N_3 = Total number of time slips handled (one day's slips).

		H/E
B =	Time for sorting each time slip into direct labor (incentive), indirect labor and day work.	.000267
F =	Time for sorting each "incentive" time slip into "parts" category.	Table I
I =	Time for sorting each "parts" time slip into "numerical" sequence.	.000286

Since we operate against standard costs which are established once a year and are based on our standard times, it is necessary for us to receive the time slips from these sections each day in order that our rate setter may compare the standard time on each time slip with the cost standard. But before she can do this our typist-clerk has to sort the time slips into three categories:

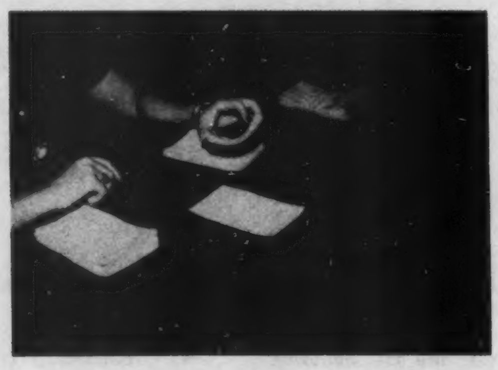
a. Direct Labor Incentive
b. Indirect Labor
c. Day Work

The time slips, three packs, one from each of the above named sections, are placed on the typist-clerk's desk each day by a member of the timekeeping department. The time slips are 4" x 6" and each pack is held by a rubber band under which is an identifying slip of paper indicating the section to which the slips belong. This slip of paper is 4" wide and 6 1/4" long.

The clerk proceeds as follows:

A. Pick up pack of departmental time slips and remove rubber band.

1. Reach 12" with left hand and grasp pack between thumb and middle finger. Squeeze pack in transit toward right hand to cause it to valley.
2. Move right hand to and grasp rubber band and pull it off pack and drop it on bench.



(Scene I)

M. T. M. ANALYSIS

DESCRIPTION - L.H.	L.H.	TMU	R.H.	DESCRIPTION – R.H.
Reach to stack of time slips.	R12B	12.9		
Grasp sides with middle finger and thumb. (squeeze pack in transit to form valley in pack) (See Scene I)	G1A	1.7		
Move pack to R.H.	M12A	12.9	(R8A)	Reach to rubber bank on pack.
		1.7	G1A	Grasp rubber band.
		10.6	M8B	Remove rubber band.
		1.7	RL1	Drop on desk.
		7.9	R8A	Reach to identification slip.
		1.7	G1A	Grasp slip.
Regrasp pack	(G2)	20.6	M24B	Move slip to waste basket.
		1.7	RL1	Drop slip into basket.
Move top slip off of pack with thumb.	(M1B)	22.4	R12A	Reach back to pack in L.H.
		95.8		

No.	ELEMENT DESCRIPTION	Element Time TMU	CONVERSION FACTOR .00001 Leveled Time	% Allow.	Element Time Allowed	Occ. / Job	Total Time Allowed
A.	Pick up pack of departmental time slips and remove rubber band.	95.8	.000958	10%	.001052	3	.003156

B. Sort time slips into Direct Labor (incentive), Indirect Labor and Day Work.

1. Move slip off top of pack with the left thumb as right hand asides the previous slip into proper pile.

NOTE (1) Repeat "A" and "B" for the three packs.

NOTE (2) Slips are counted as they are sorted.

M. T. M. ANALYSIS

DESCRIPTION - L.H.	L.H.	TMU	R.H.	DESCRIPTION – R.H.
		1.7	G1A	Grasp time slip.
Move thumb back.	(R1B)	12.2	M10B	Move time slip to proper pile.
Place thumb on slip.	(G5)	1.7	RL1	Release time slip.
Move slip off top.	(M1B)	8.7	R10A	Reach to time slip.
		24.3		

NOTE: Eye focus is internal with above moves.
Slips are counted as they are sorted.

No.	ELEMENT DESCRIPTION	Element Time TMU	CONVERSION FACTOR .00001 Leveled Time	% Allow.	Element Time Allowed	Occ. / Piece	Total Time Allowed
B.	Sort time slips into direct labor (incentive), indirect labor and day work.	24.3	.000243	10%	.000267	1	.000267

C. Record the total number of time slips.

1. Pick up pencil in right hand and record the total number of time slips (for the three departments) in the proper space on the report. See Figure "A" (page 64). Lay pencil aside on desk.

M. T. M. ANALYSIS

DESCRIPTION – L.H.	NO.	L.H.	TMU	R.H.	NO.	DESCRIPTION – R.H.
			10.1	R8B		Reach to pencil.
			1.7	G1A		Grasp pencil.
			10.6	M8C		Move pencil to form.
						Regrasp pencil
			6.8	M	4	Write three digits.
			11.2	P	2	Write three digits.
			8.0	M5B		Aside pencil.
			1.7	RL1		Release pencil.
			9.3	R8E		Move hand back to work station.
			59.4			

No.	ELEMENT DESCRIPTION	Element Time TMU	CONVERSION FACTOR .00001 Leveled Time	% Allow.	Element Time Allowed	Occ. / Job	Total Time Allowed
C.	Record the total number of time slips.	59.4	.000594	10%	.000655	1	.000655

D. Get pile of time slips, put rubber band around pack and aside.

1. Pick up stack of time slips with left hand.
2. Move to right hand.
3. Jog or bunch time slips with both hands. (See Scene II)
4. Get rubber band from desk and place around day work pack of time slips.
5. Aside pack to desk with left hand.

NOTE: Repeat for indirect labor time slips.

(Scene II)

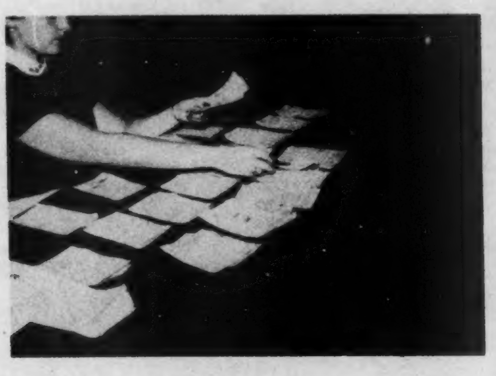
M. T. M. ANALYSIS

DESCRIPTION — L.H.	No.	L.H.	TMU	R.H.	No.	DESCRIPTION — R.H.
Reach to pack		R12B	12.9			
Place thumb on pack.		G5	0			
Move fingers under pack.		M3B	5.7			
Regrasp.	2	G2	11.2	(R8E)		Reach toward L.H.
Turn pack 90°.		T90S	5.4	(G1A)		Grasp pack.
Drop on edge between thumb and forefinger.		RL1	1.7	RL1		Drop on edge between thumb and forefinger.
Move toward R.H.		M1A	1.7	M1A		Move toward L.H.
Grasp end of pack.		G1A	1.7	G5		Release pack.
Regrasp pack.		(G2)	12.9	R12B		Reach to rubber band on table.
Turn pack 45°.		T45S	3.5	G1B		Grasp rubber band.
Move middle finger to band.		(M1B)	12.9	M12A		Move to pack in L.H.
Put finger through band.		M2B	4.2			
			4.2	M2B		Move middle finger through band while thumb and index finger hold band.
			1.7	RL1		Release band with thumb and forefinger.
			4.2	M2B		Place forefinger in loop of band.
			5.7	M3B		Expand band with finger.
			6.9	M4B		Move hand over pack.
			1.7	RL1		Release band.
Aside pack		M12B	13.4			
Release pack.		RL1	1.7			
Move hand back to work station.		R10E	10.5			
			123.8			

No.	ELEMENT DESCRIPTION	Element Time TMU	CONVERSION FACTOR .00001 Levelled Time	% Allow.	Element Time Allowed	Occ. / Job	Total Time Allowed
D.	Get pile of time slips, put rubber band around pack and aside.	123.8	.001238	10%	.001360	3	.004080

E. Get pile of time slips and bunch.

1. Pick up stack of time slips with left hand.
2. Move to right hand.
3. Jog or bunch time slips with both hands. (See Scene II.)



(Scene III)

M. T. M. ANALYSIS

DESCRIPTION – L.H.	NO.	L.H.	TMU	R.H.	NO.	DESCRIPTION – R.H.
Reach to pack.		R12B	12.9			
Place thumb on pack.		G5	0			
Move fingers under pack.		M3B	5.7			
Regrasp	2	G2	11.2	(R8E)		Reach toward L.H.
Turn pack 90°.		T90S	5.4	(G1A)		Grasp pack.
Drop slips on edge of desk loosely between thumb and index finger.		RL1	1.7	RL1		Drop slips on edge of desk loosely between thumb and index finger.
Move toward R.H.		M1A	1.7	M1A		Move toward L.H.
Grasp end of pack.		G1A	1.7	RL1		Release pack.
Regrasp pack.		G2	5.6			
			45.9			

NO.	ELEMENT DESCRIPTION	Element Time TMU	CONVERSION FACTOR .00001 Levelled Time	% Allow.	Element Time Allowed	Occ. / Job	Total Time Allowed
E.	Get pile of time slips and bunch.	45.9	.000459	10%	.000505	Var.	

F. Sort "incentive" time slips into "parts" category. (See Scene III.)

(Our parts classification are determined by prefix numbers. Example: 12-0027. The "12" indicates the part is a Case and the "27" is the detail part number).

1. Grasp time slip with right hand and move to proper pile on desk.
2. Move time slip off top of pile with the left thumb during the aside of the previous time slip.

NOTE: Slips are counted as they are sorted.

M. T. M. ANALYSIS

DESCRIPTION – L.H.	L.H.	TMU	R.H.	DESCRIPTION – R.H.
		1.7	G1A	Grasp time slip.
Move thumb back.	(R1B)		Variable	Move slip to proper pile.
Place thumb on slip.	(G5)	1.7	RL1	Release slip.
Move slip off of top.	(M1B)		Variable	Reach to time slip.

NOTE: Eye focus is internal with above moves.
Slips counted while sorting.

No.	ELEMENT DESCRIPTION	Element Time TMU	CONVERSION FACTOR .00001 Leveled Time	% Allow.	Element Time Allowed	Occ. / Piece	Total Time Allowed
F.	Sort "incentive" time slips into "parts" category.	3.4	.000034	10 %	.000037	Var.	

G. Count piles of incentive "parts" time slips. (See Scene IV.)

1. Count the piles of time slips by two's.

(Scene IV)

M. T. M. ANALYSIS

DESCRIPTION – L.H.	L.H.	TMU	R.H.	DESCRIPTION – R.H.
		5.0	ET $\frac{8}{24}$	Count packs of time slips by "2's".
		7.3	EF	
		12.3		

No.	ELEMENT DESCRIPTION	Element Time TMU	CONVERSION FACTOR .00001 Leveled Time	% Allow.	Element Time Allowed	Occ. / Pile	Total Time Allowed
G.	Count two piles of incentive "parts" time slips.	12.3	.000123	10%	.000135	1/2	.000068

H. Record the number of "parts" piles of time slips and the number of incentive time slips.

1. Get pencil, right hand.
2. Record the number of piles in space on report form (Figure "A").
3. Record the number of incentive time slips on report form (Figure "A").
4. Lay pencil aside.

M. T. M. ANALYSIS

DESCRIPTION – L.H.	NO.	L.H.	TMU	R.H.	NO.	DESCRIPTION – R.H.
			10.1	R8B		Reach to pencil.
			1.7	G1A		Grasp pencil.
			10.6	M8C		Move pencil to form.
						Regrasp pencil.
			34.0	M	20	Write five digits.
			56.0	P	10	Write five digits.
			8.0	M5B		Move pencil aside.
			1.7	RL1		Release.
			9.3	R8E		Move hand back to work station.
			131.4			

NO.	ELEMENT DESCRIPTION	Element Time TMU	CONVERSION FACTOR .00001 Leveled Time	% Allow.	Element Time Allowed	Occ. / Job	Total Time Allowed
H.	Record number of "parts" piles and the number of "incentive" time slips.	131.4	.001314	10%	.001400	1	.001400

I. Sort "parts" time slips into numerical sequence.

1. Reach right hand to left hand and grasp slip.
2. Remove slip from top of pile in left hand.
3. Place between fingers of left hand.
4. Release slip.

M. T. M. ANALYSIS

DESCRIPTION – L.H.	L.H.	TMU	R.H.	DESCRIPTION – R.H.
Move time slip with thumb.	(M1B)	3.7	R2A	Reach to time slip in L.H.
		1.7	G1A	Grasp time slip.
		8.0	M5B	Remove time slip.
		3.6	M2A	Move to slips to L.H.
		5.6	P1SE	Position between fingers of L.H.
Grasp slip between fingers	G1A	1.7		
		1.7	RL1	Release.
		26.0		

NOTE: Eye focus is internal with above moves.

NO.	ELEMENT DESCRIPTION	Element Time TMU	CONVERSION FACTOR .00001 Leveled Time	% Allow.	Element Time Allowed	Occ. / Piece	Total Time Allowed
I.	Sort "parts" time slips into numerical sequence.	26.0	.000260	10%	.000286	1	.000286

J. Bunch piles of "numerical" time slips and place in one pile on desk.

1. Tip pile of slips in left hand 45° as right hand reaches to slips.
2. Right hand grasps group of time slips, left hand releases and right hand tips time slips 45° toward desk with long edge parallel to desk top.
3. Allow slips to hit top of desk loosely between thumb and forefinger to jog into alignment.
4. Grasp left end of slips lightly and move to right hand between thumb and forefinger to align slips.
5. Grasp slips right hand and move aside and place on bench.

NOTE: (1) The highest prefix is jogged first and placed on desk face up, the second highest on this stack, etc.

NOTE: (2) Repeat "D" on this stack of incentive time slips.

M. T. M. ANALYSIS

DESCRIPTION – L.H.	L.H.	TMU	R.H.	DESCRIPTION – R.H.
Tip pile 45° toward R.H.	(T45S)	5.0	R3A	Reach to slips held in L.H.
		1.7	G1A	Grasp slips.
Release time slips.	RL1	1.7		
		3.5	T45S	Turn long edge of slips 45° toward desk.
		5.9	M3B	Move toward desk.
		1.7	RL1	Release slips allowing lower edges to hit top of desk and upper edges remain loosely between thumb and forefinger.
Reach to left ends of slips.	R3A	5.0		
Contact grasp slips.	G5	0		
Move slips against R.H. (between thumb and forefinger)	M1A	1.7		
		1.7	G1A	Grasp time slips.
		13.5	M10C	Move aside to desk.
		5.6	P1SE	Place in pile on bench.
		0	G5	Release.
		47.0		

NO.	ELEMENT DESCRIPTION	Element Time TMU	CONVERSION FACTOR .00001 Leveled Time	% Allow.	Element Time Allowed	Occ. / Cycle	Total Time Allowed
J.	Bunch piles of "numerical" time slips and place in one pile on desk.	47.0	.000470	10%	.000518	Var.	

SUMMARY

A. Pick up pack of departmental time slips and remove rubber band.
B. Sort time slips into Direct Labor (incentive), Indirect Labor and Day Work.
C. Record the total number of time slips.
D. Get pile of time slips, put rubber band around pack and aside.
E. Get pile of time slips and bunch.
F. Sort "incentive" time slips into "parts" category.
G. Count piles of incentive "parts" time slips.
H. Record the number of "parts" piles of time slips and the number of incentive time slips.
I. Sort "parts" time slips into numerical sequence.
J. Bunch piles of "numerical" time slips and place in one pile on desk.

ELEMENT	UNIT OF MEASUREMENT	NO./JOB	STANDARD HOURS/UNIT	HOURS/JOB
A	Pack	3	.001052	.003156
B	Time Slip	Variable	.000267	
C	Time Slip	1	.000655	.000655
D	Pile	3	.001360	.004080
E	Pile	Variable	.000505	
F	Time Slip	Variable	Variable	
G	Pile	Variable	.000068	
H	Record	1	.001850	.001850
I	Time Slip	Variable	.000286	
J	Pile	Variable	.000518	

TABLE I

F. Sort "incentive" Direct Labor into "parts" Category.

Piles* of Parts Time Slips	H/E
2	.000212
3	.000226
4	.000255
5	.000267
6	.000279
7	.000279
8	.000290
9	.000290
10	.000290
11	.000302
12	.000314
13	.000314
14	.000314
15	.000314

***NOTE: Use N_1 for the number of piles of "parts" time slips.**

APPROVED: ______________________ **Supervisor**

MADE BY: ______________________ **Time Study Engineer**

WORK SHEET FOR TABLE I

Piles* of Parts Time Slips	Average Distance	R-A	M-B	TMU	Const. TMU	Total TMU	x .00001 x 1.10	=	H/E
2	6"	7.0	8.9	15.9	3.4	19.3	.000193	=	.000212
3	7"	7.4	9.7	17.1	3.4	20.5	.000205	=	.000226
4	9"	8.3	11.5	19.8	3.4	23.2	.000232	=	.000255
5	10"	8.7	12.2	20.9	3.4	24.3	.000243	=	.000267
6-7	11"	9.2	12.8	22.0	3.4	25.4	.000254	=	.000279
8-9-10	12"	9.6	13.4	23.0	3.4	26.4	.000264	=	.000290
11	13"	10.0	14.0	24.0	3.4	27.4	.000274	=	.000302
12-15	14"	10.5	14.6	25.1	3.4	28.5	.000285	=	.000314

* Same as N_1.

APPLICATION

Example:

Stacks of "parts" time slips	14
Total number of time slips	537
Total incentive time slips	418

See report below:

REPORT
SORT TIME SLIPS

ELEM.	INFORMATION	NO. / JOB	HOURS / UNIT	HOURS / UNIT
A.		3	.001052	
C.	CONSTANT PER JOB	1	.000655	.009291
D.		3	.001360	
H.		1	.001400	
E.		(1)		
"G."	No. of *stacks* of "Parts" T.S.	14*	.001091	.015274
J:				**
B.	Total No. of *Time Slips*	537*	.000267	.144000
F.	No. of Incentive *T.S.* sorted into "Parts"	(2) 418*	(1) ** (3) .000314	**
I.	No. of *T.S.* sorted into numerical order.	(2) 418*	.000286 .000600 **	** .250800
	CLERK: Mary Jones		TOTAL	** .410074

(1) The no. of packs determines this value.

(2) Quantity is same.

(3) See Table I for time per Time Slip.

FIGURE "A"

* The figures are entered by the clerk.

** These figures are entered and extended by the time keeper.

MTM NEWS

The MTM Association of Southern California, a chapter of the National Association, has recently elected officers for 1954-1955. They are as follows:

President	Kenneth E. Patton Modine Manufacturing Company Whittier, California
Vice-President	Donald Wheeler Robertshaw-Fulton Controls Co. Grayson Controls Division Lynwood, California
Secretary	Robert Rothschild O. B. Moore & Associates Los Angeles, California
Treasurer	Harry Snyder Security First National Bank Los Angeles, California

The MTM Association extends congratulations and best wishes for the coming year's activities of the California Chapter.

The next meeting of the Board of Directors of the MTM Association will be January 28, 1955. This meeting will be the Annual Meeting of the Association.

* * * * * *

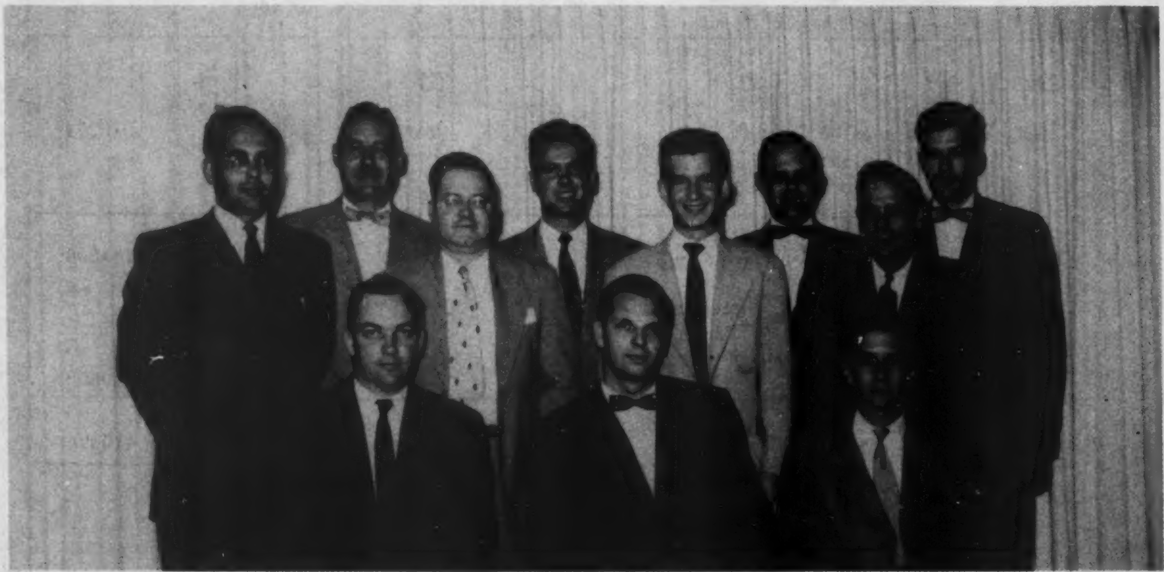
The MTM Association welcomes the following recent additions to Membership in the Association.

Canadian Arsenals, Limited, Quebec, Canada
Johns-Manville Corporation, New York, New York
Murray Manufacturing Corporation, Brooklyn, New York
SKF Industries, Philadelphia, Pennsylvania

* * * * * *

The International MTM Conference Introductory Sessions were conducted by the Montreal Chapter of the Association.

The success of these sessions was made possible by the efforts and industry of the Chapter and of the members actively participating in the program.



Montreal Chapter members participating in the October 6, 1954 program: Left to right, standing; F. G. White, J. A. B. Briggs, F. J. Dooner, R. Heaney, G. H. Webb, R. L. Bugbee, J. Archambault, M. A. Silverson: seated; D. C. Barwick, G. Y. Hamilton, L. St. Julien.

RESEARCH REPORTS

Disengage (Report 101)

This report contains a preliminary study of the element disengage. While it is still classified as tentative, the report contains some extremely interesting conclusions on the nature and theory of this element.

Reading Operations (Report 102)

The first step in the use of MTM for establishing reading time standards is contained in this report. In addition, the report contains a synopsis of the work done in this field by 11 leading authorities.

MTM Analysis of Performance Rating Systems (Report 104)

A talk presented at the SAM - ASME Time and Motion Study Conference, April 1952. It contains an analysis of performance rating systems and various performance Rating Films from an MTM standpoint.

Simultaneous Motions (Report 105)

This report represents almost two man-years' work on a study of Simultaneous Motions. It is a final report of the Simultaneous Motions project undertaken by the MTM Association. While it does not purport to provide complete and exhaustive answers to all problems in the field of Simultaneous Motions, it presents a great deal of new and valuable information which should be of interest to every MTM practitioner.

Short Reaches and Moves (Report 106)

This report contains an analysis of the characteristics of Reaches and Moves at very short distances. It develops important conclusions concerning the application of MTM to operations involving these short distance elements.

Research Methods Manual (Report 107)

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